CHAPTER 1

GENERAL

1-1. Purpose.

This manual establishes the minimum design requirements for sanitary landfills, provides engineering criteria for construction, and lists recommended practices for planning and feasibility studies.

1-2. Scope.

This manual explains applicable laws and regulations, solid waste disposal alternatives, site selection considerations, design criteria, construction methods, and operating practices for sanitary landfills. Only disposal of non-hazardous solid waste at Army installations is addressed. The information described herein is applicable to feasibility studies as well as design work.

1-3. References.

Appendix A contains a list of references used in this manual.

1-4. History of Solid Waste Disposal.

a. Before World War II, the Army disposed of refuse on land (open dumps) in remote areas of the installation and burned the combustible materials periodically. The Army did not adopt sanitary landfilling as a solid waste disposal practice until 1942, when published instructions recommended that refuse be compacted into trenches and covered daily with soil. In 1946, the Army published TM 5-634, which provided specific guidance. At that time, the primary emphasis of waste disposal was to reduce garbage odors and blowing litter and to control insects and rodents.

b. The 1958 version of TM 5-634 was the first Army guidance to address landfill site selection. Although site selection criteria dealt mainly with distance to refuse sources and access to the site, the manual did indicate that landfill sites should not have surface or subsurface drainage that might pollute a water supply.

c. These practices were undoubtedly considered "state of the art" and environmentally safe at the time. This view prevailed, even though it was common practice to codispose waste engine oil, spent solvents, industrial sludges, and municipal type wastes together in the landfill. Furthermore, no one considered that these liquids might escape from a landfill and seriously contaminate surface waters or subsurface aquifers or otherwise harm the natural environnment. In the 1960's and 1970's engineers started designing sanitary landfills that relied on the depth to ground-water, and biological, chemical, and physical mechanisms of the soil to protect the ground-water. However, more recent findings have proven that these natural mechanisms do not fully protect the environment from methane gas, a by-product of decaying organic matter, or from leachate. Because of these past practices, many of these old "sanitary landfills" are now found to be "hazardous waste sites."

1-5. Current Practice.

a. In the past, uncontrolled refuse disposal had many undesirable effects on Army installations, and the environmental legislation developed to control such wastes forced authorities to require improvements in refuse disposal processes. Surface and ground-water contamination, explosive hazards associated with uncontrolled methane gas production, increased vermin activity, and the obvious problems with refuse odors, are the main factors to consider in design of a sanitary landfill.

b. Options available to eliminate the quantity and specific types of refuse in sanitary landfills include incineration, recycling, composting yard wastes and landfills designed for a specific waste requiring permits (e.g. hazardous waste landfills, asbestos landfills, etc.). So there might be less transport of refuse, placement of landfills close to the center of population would be the most desirable situation for the designer. Adverse public sentiment and the cost and availability of land usually are the deciding factors for locating a landfill, which make transporting the refuse to a more advantageous location the preferred option for many authorities. New technologies that can produce a closed landfill system, a self contained system resulting in very little impact on the surrounding environment, have resulted in more restrictive legislation and regulations for sanitary landfills. Therefore, site selection and proper landfill design are considered the most important factors in the refuse disposal process.

1-6. Laws and Regulations.

a. *Federal*.

(1) *40 CFR 240 and 241*. For the design and

operation of new landfill sites, 40 CFR 240 and 241 were implemented by the Solid Waste Dispopsal Act of 1965 as amended by the Resource Recovery Act of 1970. These regulations, which were promulgated by the U.S. Environmental Protection Agency (USEPA) and are mandatory for all Federal agencies, and require control of leachate to prevent degradation of surface and groundwater quality.

(2) *CFR 40, Part 257.* 40 CFR 257 provides guidance on evaluating existing landfill sites to determine if they are suitable for continued use. In essence, this regulation states that landfills that pollute surface waters or contaminate underground drinking water sources should be considered "open dumps" and therefore must be either upgraded or safely closed.

(3) *40 CFR 258.* In September 1991, 40 CFR 258 was promulgated. It provided further location restrictions, operating criteria, design criteria, ground-water monitoring, corrective action requirements, and closure and post-closure care requirements. Specific requirements of 40 CFR 258 are explained in applicable chapters of this manual.

(4) *Leachate.* Landfills that release leachate into surface waters or underground drinking water sources can also be subject to the provisions of either the Clean Water Act (OWA) or the Safe Drinking Water Act (SDWA). Contaminants entering the ground-water, which are determined to be priority hazardous pollutants, require remedial action under either SDWA or the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), referred to as the "Superfund Law."

b. Army. AR 200-1, chapter 6, provides basic Army policy and guidance on solid waste management. However, this document provides little information regarding the requirements for leachate control or long-term care. Consequently, managers of solid waste activities at Army installations must refer to the aforementioned Federal regulations, and state and local authorities to determine the full extent of requirements.

c. State.

(1) Enforcement of Federal solid waste regulations is now delegated to many states. The law delineating state responsibilities is the Resource Conservation and Recovery Act (RCRA). The mechanism used to discharge this responsibility is the Solid Waste Management Plan, developed by a state and approved by USEPA. An outgrowth of these management plans is definitive state regulations that prescribe design and operating standards for landfills. Most state regulations also require that every landfill operator obtain a permit for each facility, and that a registered professional engineer design the disposal facilities.

(2) A majority of states specifically require ground-water monitoring systems, and many of the remainder have general authority to impose ground-water monitoring on a site-specific basis. Almost all of the states have either requirements in their regulations, or have general authority to impose corrective action. Approximately half of the states require methane gas monitoring and/or surface water monitoring. While most states have general guidelines or requirements for facility closure and post-closure maintenance requirements, these requirements vary widely in stringency.

(3) Most states have issued separate regulations on hazardous waste management. Consequently, whenever a leachate release contains a hazardous substance, corrective action will be required and will be guided primarily by these regulations.

1-7. Solid Waste Characteristics.

In the past, lawn and garden trimmings have made up approximately 12% of the waste in municipal landfills. Much lower amounts can be expected from most Army installations. Also, many installations and municipalities are no longer disposing of yard or garden wastes in sanitary landfills; instead the waste is land farmed or disposed in non-sanitary landfills, such as approved fill areas. To further reduce the waste streams, many installations now burn wood, recycle metal and other materials, and use dirt, concrete, and brick for erosion control projects. The make-up of landfills vary, but if an installation limits solid wastes to what would normally be placed in a municipal landfill, the composition should compare with table 1-1.

1-8. Alternate Disposal Methods.

a. Alternatives. The using service will select the method of solid waste disposal to be used. The options generally available are contractual arrangements, sanitary landfills, and incineration, but new methods may be introduced as they become economically viable. The preferred method of solid waste disposal is to participate in a regional solid waste management system, if feasible. In the absence of a regional system, contractual arrangements for hauling and/or disposal with a public agency or a commercial entity may be practical. When contractual arrangements are impractical and where conditions are suitable, alternative methods to sanitary landfills may in-

Table 1-1. Typical Composition of Municipal Solid Wastes

	Percent by mass	
Component	*Range*	*Typical*
Food wastes	6-26	14
Paper	15-45	34
Cardboard	3-15	7
Plastics	2-8	2
Textiles	0-4	0.5
Rubber	0-2	0.5
Garden trimmings	0-2	12
Wood	0-20	2
Miscellaneous organics	0-5	4
Glass	4-16	4
Tin cans	2-8	4
Nonferrous metals	0-1	4
Ferrous metals	1-4	4
Dirt, ashes, brick, etc.	0-10	4

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clude incineration with energy recovery, recycling of suitable materials, and composting organic matter.

b. Comparison of Alternatives.

(1) Sanitary landfilling is generally preferred over other alternatives, because there is less handling and processing of materials. However, a landfill may not be the most economical or environmentally preferred method. The rapid filling of available sites, and outdated containment systems of existing landfills have forced authorities to consider alternative disposal methods. A combination of the options listed above may be the best solution, but may depend on several factors at the installation, including: the type of refuse, availability of land for site selection, incinerator accessibility, economic feasibility for recycling usable materials, suitable locations for large quantity composting, and possible contractual arrangements that would combine several of these methods.

(2) The main advantage of a sanitary landfill is that handling and processing of refuse is kept to a minimum. Handling is limited to the pickup and transport of the waste, the spreading of refuse, and covering with a suitable cover material. Composting requires more handling before it is stored to decompose, and may only be suitable for disposing of organic matter such as yard waste. Therefore, composting may not be a viable alternative for a majority of the situations. Recycling requires that only specific materials be processed, and requires more handling than most other methods, but can reduce solid wastes in a landfill by as much as 30%. After the material is collected, it may go through various changes and processes, at a substantial expenditure of energy, before it results in a reusable form. Recyclable materials include paper, plastics, glass, metals, batteries, and automobile tires. Incineration with energy recovery has been used for some time, but has come under increased scrutiny because of new laws and regulations aimed at reducing air pollution and the resulting products of incineration may be even more dangerous than originally thought. Clean air laws, and negative public sentiment may require additional expense and waste treatment that can make incineration the least favored alternative. Ash residue and bulky refuse which are not burned during incineration will still require disposal. The main advantage of incineration is the capability to reduce landfill use by 70-80%.

(3) The critical factors which must be considered include: the possibility of surface and groundwater contamination, explosions from gases generated by waste decomposition, airborne ash from incineration, odors from the composting process, and the lack of suitable sites with the capacity for long term use are critical factors which must be considered. Design authorities must make decisions which are critical to the areas surrounding the proposed sanitary landfill. Selecting a method for proper and complete disposal can be a very intricate process.

1-9. Solid Waste Stabilization in a Sanitary Landfill.

a. Alternatives. While past designs required that landfills receive extended maintenance after closure, increasingly stringent regulations and the shrinking availability of suitable sites for landfills may force the designer to consider some of the new technologies that can speed up solid waste stabilization. Stabilization is achieved by the degradation of the deposited refuse, mainly through decomposition, which reduces the pile volume and can lead to surface subsidence. Landfill designs offer two options: dry or sealed landfills; and wet landfills.

b. Dry Landfills. Dry landfills are designed to seal off the solid waste in hopes of reducing leachate production, therefore decreasing the possibility of leachate leakage outside of the landfill system. Unfortunately, studies show that solid waste stabilization is limited with the "dry" system. Archaeological investigations have found 20 years old refuse in existing landfills which was preserved from the elements. Because the waste was sealed off, it was protected from the rotting influences of air and moisture. While this method may require low maintenance, it could possibly require maintenance for several decades, with little actual stabilization or decomposition of the solid waste.

c. Wet landfills.

(1) *Biodegradation.* Current studies have shown that wet systems, or landfills that use leachate recirculation, are becoming the favored option when considering solid waste stabilization as a priority for the landfill. Since most biodegradation results from complex interactions of microbial bacteria, these "wet landfills" may also require the addition of air along with the recirculation of leachate. Lined landfills that have been properly designed and constructed provide leachate containment with a low risk of leakage.

(2) Gas *Generation*. Methane gas generation is considered to be a problem at some landfills. Therefore, the production of methane and other gases should be considered in the design. The economics of extracting methane gas as an energy source makes accelerated methane gas production a benefit of wet landfill designs. This may require that containing and recovering the methane gas be made part of the landfill design.

(3) *Stabilization Time*. The main advantage of a wet landfill is the increased rate of stabilization of the solid waste in the landfill. Studies show that the process of leachate recirculation can speed up the rate of waste decomposition, by an active biological process in a landfill from 50 or more years for a dry landfill, to just 5 or 10 years for a wet landfill. Long term financial savings through eliminated or reduced maintenance and long term monitoring may outweigh the initial start-up costs and requirements for leachate recirculation, and should be considered in the design of the sanitary landfill.